different than were the normally diverse individuals of the original species." Again (p. 220), "Mutative variations commonly obey MENDEL'S laws." But none of the fully demonstrated mutations now known strictly obey MENDEL'S law, though the reverse inference has been frequently made and probably with good cause, namely, that the Mendelian inheritance of a character indicates its origin by mutation. On p. 221 he says, "The general rule must be that new variant gametes conjugate with gametes of the unmutated parental type, and thus have from the first the reproductive status of Mendelian crosses." This is a good suggestion and should be kept in mind by students of evolution, as should also his discussion of the relation between the origin of characters and their effect in the modification of species; but the Oenothera mutants, the best known of all, breed true from the instant of their first appearance, and no instance is known in which a new form has been shown to be already a Mendelian hybrid at the time of its first appearance.

It is difficult to understand why COOK should say, "Mutation is not a period but a condition," since no one ever said or intimated that it is a period. It is neither a period nor a condition, but an act or the result of that act. He says, "Species have more essential evolutionary differences than mutations, though mutations are at the same time more definitely different." Yet the Oenothera mutants are recognized by excellent taxonomists as differing from each other both as to quality and degree, just as wild species differ. Other statements regarding the Oenotheras are not in agreement with published facts, as for instance his statement that *O. Lamarckiana* is dominant over *O. lata* to the extent of 85 per cent.—GEORGE H. SHULL.

The origin of angiosperms.—ARBER and PARKIN[9] have proposed a theory of the origin of the angiosperms, based on the recent development of knowledge in reference to living and fossil forms, especially the Bennettitales. Contrary to the ENGLER scheme, they do not regard such apetalous groups as the Piperales, the Amentiferae, and the Pandanales as representing primitive angiosperms, but rather as reduction forms from those possessing a perianth. The primitive typical angiospermous floral structure is claimed to have been an "amphisporangiate" (substituted for the commonly used terms "bisporangiate" or "ambisporangiate," as the proper antithesis of "monosporangiate") strobilus, in which the megasporophylls are above the microsporophylls and there is a well-marked perianth. Such a strobilus the authors call an "anthostrobilus," restricting "flower" ("eu-anthostrobilus") to angiosperms. A "pro-anthostrobilus" is an earlier form, such as is displayed by the Bennettitales, in which the megasporophylls are not closed, and the microsporophylls have not reached the real stamen form. This implies the existence of a direct ancestral group of the angiosperms, with a strobilus like that of the Bennettitales, and to this hypothetical group the

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[9] ARBER, E. A. NEWELL, and PARKIN, JOHN, On the origin of angiosperms. Jour. Linn. Soc. London Bot. **38**: 29–80. 1907.

authors give the name "Hemiangiospermeae." To this hypothetical group the Bennettitales are related, but are specialized in their own way.

The living angiosperms most nearly related to the "Hemiangiospermeae" are the Ranales, especially the Magnoliaceae, whose probable primitive position has begun to force itself upon the attention of morphologists ever since WIELAND'S studies of Bennettitales; and from this same Ranales plexus the monocotyledons probably diverged. The monophyletic origin of angiosperms is maintained, but to the reviewer it seems altogether probable that while a simple strobilus, like that of Bennettitales, resulted in such a flower as that of the Ranales, a compound strobilus, like that of the Gnetales, may have resulted in such an inflorescence as an ament.

An inevitable suggestion is that the pteridosperms developed in the Mesozoic by two distinct methods: (1) by sporophylls aggregated into monosporangiate strobili leading to the modern cycads; (2) by both kinds of sporophylls massed into one amphisporangiate strobilus, as in Bennettitales.

The paper contains many interesting and suggestive details which cannot be mentioned here, and it brings together in every useful form views which have been working like leaven, but which had not been expressed.

Another paper dealing with the method of origin of angiosperms, rather than with their phylogeny, is that by COOK.[10] It is a theoretical discussion of the possibility of angiosperms arising directly from liverworts, such as Anthoceros, through the persistent aposporous development of the prothallia, which serve "as means of attachment for the young plant during its embryonic stages." "Apospory need not interfere with the formation of sex cells, nor with the continuation of truly sexual methods of reproduction." It seems that in this elimination of spores "mitapsis" is simply deferred to later generations of cells, in angiosperms being carried over into the aposporous female prothallium. From an Anthoceros capsule an angiosperm with two cotyledons could be derived; and then a many-leaved stem could be built up by the successive addition of "metamers." The elimination of megaspores in the life-history of angiosperms results in such new interpretations of structure that the reviewer must confess he is unable to follow the discussion. For example, "the part of the angiosperm which, in the present view, might correspond to the prothallus itself, is the nucellus. And even this relation would not be direct, for the nucellus of the angiosperms might not be homologous with the nucellus of the conifers and cycads, which, if current interpretations are correct, is more analogous to the placenta of the mammal than to an aposporous prothallus." Also, "the gymnosperms may be supposed to have the ovules and seeds naked because they are still borne in an endosperm which corresponds to the primitive, vegetatively functional prothallus, though it now remains attached to the much more highly developed double-celled structure which corresponds, in turn, to the capsule of the liverwort and the moss, the

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[10] COOK, O. F., Origin and evolution of angiosperms through apospory. Proc. Wash. Acad. Sci. 9:159–178. 1907.

frond of the fern, and the leafy axis of the club moss." When revolutionary ideas are combined with evident lack of familiarity with the structures under discussion, it is no wonder that confusion is the result.—J. M. C.

Development of heterotypic chromosomes.—Two years ago MOTTIER published a preliminary account[11] of his views as to the development of the heterotypic chromosomes in pollen mother cells, and the full paper has just now appeared.[12] His paper consists of two parts: first, a statement of the results of his studies of five angiosperms (*Podophyllum peltatum, Lilium Martagon, L. candidum, Tradescantia virginica,* and *Galtonia candicans*); and second, a discussion of several cytological phenomena, reviewing the work of previous investigators and giving a purely theoretical account of the possible relationships of chromosomes to hereditary characters.

The few points which he has specially emphasized in his own studies on these five forms are as follows: (1) The resting nucleus of the pollen mother cell consists of a linin net, the ground matrix in which the chromatin is held. The chromatin is in the form of very fine granules of uniform size or in larger aggregations or clumps which are composed of smaller granules. (2) In synapsis he has not found a union of two spirems. (3) The loose or hollow spirem which has emerged from synapsis is of the double nature, which he believes to be due to a new longitudinal splitting that provides for the second division. (4) Segmentation of this loose or hollow spirem into chromosomes takes place during or following the second contraction stage. The second contraction consists in the arrangement of a large part of the spirem into loops that tend to radiate from a loosely entangled central mass of the thread. The loops are formed by the approximation of the parallel portions of longer turns of the spirem. Each loop represents a bivalent chromosome, each parallel part being a single chromosome. The two parallel parts or chromosomes are arranged tandem, or end to end in the spirem. (5) He seems to emphasize the point that the shortening and thickening of the spirem occurs, in the main, after segmentation of the spirem into chromosomes.

Taking his results as a whole, they confirm essentially the view already advanced by FARMER and MOORE, SCHAFFNER, and STRASBURGER. His theoretical discussion starts from this point: he has never found the number of chromosomes to be represented by prochromosomes in presynaptic stage; all identity of such bodies is lost. He thinks granules in the resting nucleus should be connected with smaller units, the pangens (following the terminology of DEVRIES); and with a purely theoretical consideration of the pangens and their relation to chromosomes and to heredity, the paper closes.—S. YAMANOUCHI.

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[11] MOTTIER, D. M., The development of the heterotypic chromosomes in pollen mother cells. BOT. GAZETTE **40**:171–177. 1905.

[12] MOTTIER, D. M., The development of the heterotypic chromosomes in pollen mother cells. Annals of Botany **21**:309–347. *pls. 27, 28.* 1907.